Spencer R. Szabados

Contact Information

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About

Graduate student at University of Waterloo supervised by Yao-liang Yu, specializing in Machine Learning; specifically, Statistically based methods such as Sum Product Networks and Diffusion Models. My background is in Applied Mathematics and Computer Science. Passionate about problem solving, with key areas of interest being Computational Mathematics and Statistics, Numerical Analysis. Avid reader, mostly on topics relating to Human Decision Making, Finance, and a more casual obsession of hard Sci-fi in general.

Education and Certificates

Jan. 2023 - Dec. 2024	Master's of Mathematics in Computer Science, **University of Waterloo**, Canada. Specializing in Machine Learning. Supervised by Yaoliang Yu.
Feb. 2022	Bachelor's of Science in Mathematics, **University of Manitoba**, Canada. Specialized in Applied Mathematics and Theoretical Computer Science. Graduated with Distinction.
June. 2020	*Certificate* in Front-End Web Development *(15 hours)*, **Udemy**, Instructed by Joseph Delgadillo and Nick Germaine. Course detailed the use of html5, css, JavaScript, and jQuery in the design and deployment of custom dynamic websites.
June. 2016	Highschool Diploma, **Institut Collégial Vincent Massey Collegiate**, Canada. Graduated with Honors.

Awards

July. 2024	Vector Institute Research Bursary.	($2000)
	Awarded to full-time graduate studies at a Canadian educational institution during the Fall 2022 and/or Winter 2023 semesters in good academic standing and are supervised by a Vector Faculty Member.	
Jan. 2023	University of Waterloo Graduate Scholarship.	($10,000)
	Awarded to graduate students registered full time in a Master's program with a minimum first-class (80%) cumulative average in their current program or over the last two full-time academic years.	
Jan. 2022	Faculty of Science Undergraduate Research Bursary.	($10,000)
	Awarded to undergraduate students to fund their research while working under the supervision of individual professors. This was awarded to me twice working under Stephane Durocher.	
Oct. 2021	Philosophia Mathematica Prize in Applied Mathematics.	($3850)
	Awarded to best applied mathematics student in either second or third year.	
Sept. 2016	Faculty of Science Entrance Bursary.	($2000)

Publications

2024	*Diffusion Models with Group Equivariance.* (ICML2024 SPIGM Workshop) Haoye Lu, **Spencer Szabados**, and Yaoliang Yu. This paper focuses on structure-preserving diffusion models (SPDM), a subset of diffusion processes. We complement existing sufficient conditions for constructing SPDM by proving complementary necessary ones. Within this framework, we propose a method of preserving the alignment between endpoint couplings in bridge models to design a novel structure-preserving bridge model.

2024 *Structure Preserving Diffusion Models.* (Preprint)
Haoye Lu, **Spencer Szabados**, and Yaoliang Yu.
This paper introduces structure-preserving diffusion models (SPDM), a novel approach for learning distributions with inherent symmetries. Theoretical conditions are developed to ensure that diffusion process preserves symmetry, enabling equivariant data sampling trajectories.

2023 *CM-GAN: Stabilizing GAN Training with Consistency Models.* (ICML2023 SPIGM Workshop)
Haoye Lu, Yiwei Lu, Dihong Jiang, **Spencer Szabados**, Sun Sun, and Yaoliang Yu.
To overcome GAN training instability we replace the standard generator architecture with a pre-trained Consistency Diffusion Model. In this way, we provide a method to combine the main strengths of diffusion and GAN models while mitigating both their major drawbacks.

2022 *Curve Stabbing Depth: Data Depth for Plane Curves.* (CCCG 2022.)
Stephane Durocher and **Spencer Szabados**.
A novel depth measure for plane curves and functional data is proposed from a computational geometry perspective, focusing on the development and analysis of an exact algorithm for computing the depth of arrangements of polylines. The proposed depth measure does not depend on assumptions about the underlying population from which curves are drawn, nor on notions of comparative curve morphology.

EMPLOYMENT

INDUSTRY

AUG.-PRESENT 2024	Machine Learning Contractor **Coastal Carbon** (url), Waterloo. Responsible for the design, evaluation, and implementation of latent space diffusion models for remote sensing applications using multi-spectral satellite imagery.

ACADEMIC

JAN.-APR. 2024 **SEP.-AUG. 2023**	Teaching Assistant CS335 - Computational Methods in Fiance, **University of Waterloo**, Waterloo. Covering the design and analysis of algorithms for simulating financial stock pricing, the derivation and theory surrounding stochastic differential equations, Black-Scholes finance model, etc...)
JAN.-APR. 2023	Teaching Assistant CS330 - Infrastructure Management, **University of Waterloo**, Waterloo. Covering the design and analysis Computing Infrastructure and Networking, how to price compare distributor options, etc...
MAY.-AUG. 2022 **JAN.-APR. 2022**	Undergraduate Research Assistantship, **University of Manitoba**, Winnipeg. Assistantship Recently extended for an additional term. Due to my academic standing and complementary performance within Dr.Stephane Durocher's co-listed graduate course on Computational Geometry. I received a bursary to further my academic development through a collaborative research project with Dr.Durocher, working on the definition and analysis of a novel depth measure and associated exact algorithm for curve and functional data. See, *Curve Stabbing Depth: Data Depth for Plane Curves.* above.
JAN.-APR. 2022	Teaching Assistant for CS3170 Advanced Design of Algorithms, **University of Manitoba**, Winnipeg. Covering the design and analysis of *advanced* algorithms and data structures with adherence to established protocols and standards. (e.g., Amortized analysis, Fibonacci heaps, Randomized data structures and Expected running time analysis, Skip lists etc...)

Volunteer Experience

May.-Aug. 2024	Directed Reading Program (DRP) Mentor, **University of Waterloo**, Waterloo. The woman in mathematics directed reading program (DRP) is an initiative that aims to provide an opportunity for undergraduate students (mentees), who identify as women or underrepresented gender identities, to work with graduate students on a mathematical project. During this time I mentored two undergraduates on machine learning methods (latent space models) and measures of statistical depth (and combinatorial data depth) for out-of-distribution diction methods.
Jan. 2022 - Jan. 2023	Lab organizer (GADA Lab), **University of Manitoba**, Winnipeg. Organizer for the Geometry Algorithms and Distributed Algorithms open problem solving sessions. These meetings were a platform for new students and other members of the lab to collaborate on open problems in the fields of Computational Geometry, Graph Algorithms, Distributed Algorithms, etc...

Skills

Proficient in various programming languages and frameworks, with a focus on machine learning:

Languages :	PYTHON *(proficient)*, C *(comfortable)*, JULIA, R, JAVA.
Machine Learning Frameworks :	PYTORCH *(2+ years experience)*, TENSORFLOW, JAX *(currently learning)*. Implemented various machine learning architectures from scratch using PYTORCH, including auto-encoders, U-Nets, GANs, etc.
Distributed Computing :	Skilled in training machine learning models on distributed environments, such as multi-node GPU clusters, using tools like SLURM.
Web-design :	HTML5, CSS, JAVASCRIPT, HUGO *(web framework)*.
Technologies :	GIT, DOCKER *(used for all my ML projects)*, SLURM.

Data Science

Experienced in using R to perform rudimentary computational data analysis for the purposes of data communication and summary, such as Data Sanitation best practices, k-dimensional regression with Data inferencing and prediction on large samples, generating multivariant sample statistics (e.g., Tukey median, Oja median, Weber point, generalizations of α-trimmed means), along with numerous standard data visualizations (e.g., Box-plots, Density and Heat maps, etc...).